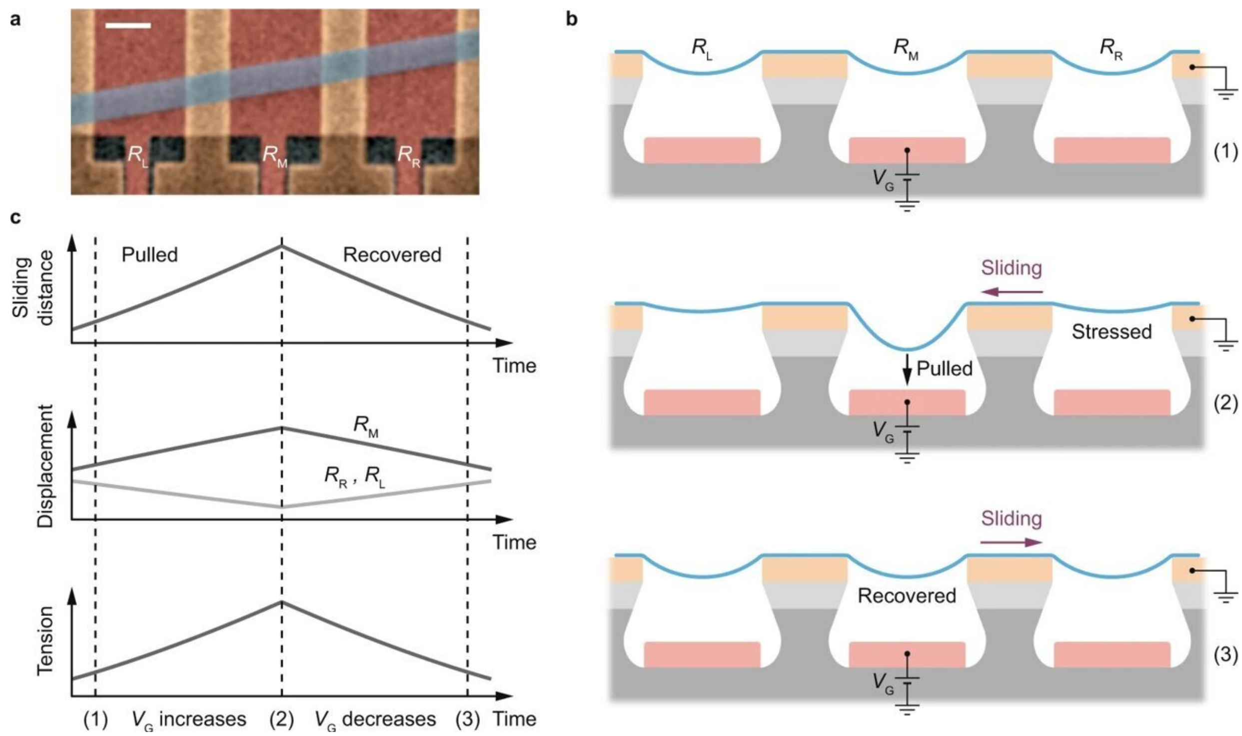
# Developing sliding nanomechanical resonators

November 29 2022




Physics of the reversible sliding. Credit: *Nature Communications* (2022). DOI: 10.1038/s41467-022-34144-5

In a recent study published in *Nature Communications*, a research team led by Prof. Guo Guangcan from the University of Science and Technology of China (USTC) of the Chinese Academy of Sciences developed nanomechanical resonators based on a graphene substrate, and made nanoresonators slidable across clamping points.

Clamping conditions determine the motion of a vibrating object. This principle inspires not only the invention of musical instruments, but also the creation of different types of mechanical resonators at the nanoscale. Among them, the nanomechanical resonators, with advantages of light weight, high frequency and tunability, are usually fixed to a supporting substrate. However, it remains a challenge to modulate the dynamics of nanomechanical resonators via other fixing methods.

In previous work, the research team developed nanomechanical resonators by pre-fabricating substrate, preparing electrodes, and transferring a thin membrane of few-layer graphene (FLG). On the resonators, the graphene could slide on the supporting electrodes.

The team found that the resonant frequency of the device depended on the magnitude of the applied gate voltage as well as the way it was applied.

To elucidate the novel experiment result, the research team proposed a sliding nanomechanical oscillator model. They discovered that increasing the gate voltage would promote the stress of graphene, which boosted the resonant frequency. Besides, the quasi-static pulling force produced by a gate voltage decreased the resonant frequency. The competition between the two mechanisms induced the occurrence of a frequency loop. The experimental results were accurately reproduced by the research team using theoretical calculations.

The research team found that the area of the frequency loop was proportional to the amount of energy loss due to friction during sliding.

This work provides new insights into investigating nanoscale friction and opens up possibilities for realizing new fixing methods at the nanoscale.

**More information:** Yue Ying et al, Sliding nanomechanical resonators, *Nature Communications* (2022). DOI: 10.1038/s41467-022-34144-5

Provided by University of Science and Technology of China